

TABLE 6
RECOMMENDED AND ADOPTED CHEMICAL ACCUMULATION/CONCENTRATION METHODS *

| Chemical | EPA Recommended Method | FDEP Adopted Method |
|------------------------------------|---------------------------|------------------------|
| 1,1,1-Trichloroethane 71556 | BAF | |
| 1,1,2,2-Tetrachloroethane 79345 | BAF | BCF |
| 1,1,2-Trichloroethane 79005 | BAF | |
| 1,1-Dichloroethylene 75354 | BAF | BCF |
| 1,2,4-Trichlorobenzene 120821 | BAF | |
| 1,2-Dichlorobenzene 95501 | BAF | |
| 1,2-Dichloroethane 107062 | BAF | |
| 1,2-Dichloropropane 78875 | BAF | |
| 1,2-Diphenylhydrazine 122667 | BAF | |
| 1,3-Dichlorobenzene 541731 | BAF | |
| 1,3-Dichloropropene 542756 | BAF | |
| 1,4-Dichlorobenzene 106467 | BAF | |
| 2,3,7,8-TCDD (Dioxin) 1746016 | BCF | |
| 2,4,6-Trichlorophenol 88062 | BAF | BCF |

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| Chemical | EPA Recommended Method | FDEP Adopted Method |
|--|---------------------------|------------------------|
| 2,4-Dichlorophenol 120832 | BAF | BCF |
| 2,4-Dimethylphenol 105679 | BAF | |
| 2,4-Dinitrophenol 51285 | BAF | BCF |
| 2,4-Dinitrotoluene 121142 | BAF | BCF |
| 2-Chloronaphthalene 91587 | BAF | |
| 2-Chlorophenol 95578 | BAF | BCF |
| 2-Methyl-4,6-Dinitrophenol 534521 | BAF | |
| 3,3'-Dichlorobenzidine 91941 | BAF | |
| 3-Methyl-4-Chlorophenol 59507 | BAF | |
| Acenaphthene 83329 | BAF | BCF |
| Acrolein 107028 | BAF | |
| Acrylonitrile 107131 | BAF | |
| Aldrin 309002 | BAF | BCF |
| alpha-Hexachlorocyclohexane (HCH) 319846 | BAF | |
| alpha-Endosulfan 959988 | BAF | |

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| Chemical | EPA Recommended Method | FDEP Adopted Method |
|---|---------------------------|------------------------|
| Anthracene 120127 | BAF | BCF |
| Antimony 7440360 | BCF | BCF |
| Arsenic 7440382 | BCF | |
| Asbestos 1332214 | | |
| Benzene 71432 | BAF | BCF |
| Benzidine 92875 | BAF | |
| Benzo(a)anthracene 56553 | BAF | |
| Benzo(a)pyrene 50328 | BAF | |
| Benzo(b)fluoranthene 205992 | BAF | |
| Benzo(k)fluoranthene 207089 | BAF | |
| beta-Hexachlorocyclohexane (HCH) 319857 | BAF | BCF |
| beta-Endosulfan 33213659 | BAF | |
| Bis(2-Chloro-1-methylethyl) Ether 108601 | BAF | |
| Bis(2-Chloroethyl) Ether 111444 | BAF | |
| Bis(2-Ethylhexyl) Phthalate 117817 | BAF | |

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| Chemical | EPA Recommended Method | FDEP Adopted Method |
|---------------------------------|---------------------------|------------------------|
| Bromoform 75252 | BAF | BCF |
| Butylbenzyl Phthalate 85687 | BAF | |
| Carbon Tetrachloride 56235 | BAF | BCF |
| Chlordane 57749 | BAF | BCF |
| Chlorobenzene 108907 | BAF | |
| Chlorodibromomethane 124481 | BAF | BCF |
| Chloroform 67663 | BAF | BCF |
| Chrysene 218019 | BAF | |
| Copper 7440508 | | |
| Cyanide 57125 | BCF | |
| Dibenzo(a,h)anthracene 53703 | BAF | |
| Dichlorobromomethane 75274 | BAF | BCF |
| Dieldrin 60571 | BAF | BCF |
| Diethyl Phthalate 84742 | BAF | |
| Dimethyl Phthalate 131113 | BAF | |

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| Chemical | EPA Recommended Method | FDEP Adopted Method |
|---|---------------------------|------------------------|
| Di-n-Butyl Phthalate 84742 | BAF | |
| Endosulfan Sulfate 1031078 | BAF | |
| Endrin 72208 | BAF | |
| Endrin Aldehyde 7421934 | BAF | |
| Ethylbenzene 100414 | BAF | |
| Fluoranthene 206440 | BAF | BCF |
| Fluorene 86737 | BAF | BCF |
| gamma-Hexachlorocyclohexane (HCH) [Lindane] 58899 | BAF | |
| Heptachlor 76448 | BAF | BCF |
| Heptachlor Epoxide 1024573 | BAF | |
| Hexachloroene 118741 | BAF | |
| Hexachlorobutadiene 87683 | BAF | BCF |
| Hexachlorocyclopentadiene 77474 | BAF | |
| Hexachloroethane 67721 | BAF | |
| Indeno(1,2,3-cd)pyrene 193395 | BAF | |

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| Chemical | EPA Recommended Method | FDEP Adopted Method |
|---|---------------------------|------------------------|
| Isophorone 78591 | BAF | |
| Methylmercury 22967926 | BAF | |
| Methyl Bromide 74839 | BAF | |
| Methylene Chloride 75092 | BAF | BCF |
| Nickel 744000 | BCF | |
| Nitrobenzene 98953 | BAF | |
| N-Nitrosodimethylamine 62759 | BCF | |
| N-Nitrosodi-n-Propylamine 621647 | BCF | |
| N-Nitrosodiphenylamine 86306 | BCF | |
| Pentachlorophenol 87865 | BAF | BCF |
| Phenol 108952 | BAF | |
| p,p'-Dichlorodiphenyldichloroethane (DDD) 72548 | BAF | |
| p,p'-Dichlorodiphenyldichloroethylene (DDE) 72559 | BAF | |
| p,p'-Dichlorodiphenyltrichloroethane (DDT) 50293 | BAF | BCF |

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| Chemical | EPA Recommended Method | FDEP Adopted Method |
|---|---------------------------|------------------------|
| Polychlorinated Biphenyls (PCBs) 1336363 | BCF | BCF |
| Pyrene 129000 | BAF | BCF |
| Selenium 7782492 | BCF | |
| Tetrachloroethylene 127184 | BAF | BCF |
| Thallium 7440280 | BCF | BCF |
| Toluene 108883 | BAF | |
| Toxaphene 8001352 | BAF | |
| trans-1,2-Dichloroethylene 156605 | BAF | |
| Trichloroethylene 79016 | BAF | BCF |
| Vinyl Chloride 75014 | BAF | |
| Zinc 7440666 | BCF | |

*** Summary:**

Table 6 identifies the bioaccumulation or bioconcentration methodology used by EPA to calculate national recommended water quality criteria for 97 toxic pollutants to protect human health and by FDEP to calculate adopted water quality criteria for 31 toxic pollutants to protect human health. The former are based on individual water quality criteria documents for toxic pollutants hyperlinked in *National Recommended Water Quality Criteria - Human Health Criteria Table*, <https://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table> (accessed Dec. 31, 2021). The latter are based on electronic mail

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from Kaitlyn Sutton, Environmental Administrator, Water Quality Standards Development Section, Division of Environmental Assessment and Restoration, FDEP, to David A. Ludder, Law Office of David A. Ludder, PLLC (dated Aug. 30, 2021) and Fla. Admin. Code r. 62-302.530, Table: Surface Water Quality Criteria (indicating that no criteria have been adopted for 3,3'-Dichlorobenzidine, Acrylonitrile, and gamma-Hexachlorocyclohexane (HCH) [Lindane], among others).

EPA has used bioaccumulation factors (BAFs) to calculate water quality criteria for 85 of 97 toxic pollutants. EPA has used bioconcentration factors (BCFs) to calculate water quality criteria for 12 toxic pollutants. FDEP has used bioconcentration factors (BCFs) to calculate water quality criteria for 32 toxic pollutants. FDEP has not adopted water quality criteria to protect human health for 65 toxic pollutants. FDEP's less stringent and omitted BAFs/BCFs (highlighted in yellow) underestimate the exposure of humans to toxic pollutants having systemic (non-cancer) health effects.

Comments:

Human exposure to toxic pollutants in water is primarily through consumption of contaminated water and contaminated aquatic organisms (fish and shellfish). Aquatic organisms become contaminated when they ingest toxic pollutants.

In *Water Quality Standards Handbook* (EPA 823-B-17-001 2017), Chap. 3, at § 3.3.2, EPA explained why BAFs are preferable to BCFs as follows:

Bioaccumulation refers to the uptake and retention of a chemical by an aquatic organism from all surrounding media (e.g., water, food, sediment) whereas bioconcentration refers to the uptake and retention of a chemical by an aquatic organism from water only. For some chemicals, particularly those that are persistent and hydrophobic, the magnitude of bioaccumulation by aquatic organisms can be substantially greater than the magnitude of bioconcentration. Thus, an assessment of bioconcentration alone may underestimate the extent of accumulation in aquatic biota for these chemicals.

The magnitude of bioaccumulation by aquatic organisms varies widely depending on the chemical, but can be extremely high for some persistent and hydrophobic chemicals. For such bioaccumulative chemicals, concentrations in

aquatic organisms may pose unacceptable human health risks from fish and shellfish consumption even when concentrations in water are too low to cause unacceptable health risks from drinking water consumption alone. These chemicals may also biomagnify in aquatic food webs, a process whereby chemical concentrations increase in aquatic organisms of each successive trophic level due to increasing dietary exposures (e.g., increasing concentrations from algae, to zooplankton, to forage fish, to predatory fish).

The EPA's 2000 Human Health Methodology recommends the use of bioaccumulation factors (BAFs), where available, to reflect the uptake of a contaminant from all sources (e.g., ingestion, sediment) by fish and shellfish, rather than only from the water column as reflected by the use of bioconcentration factors (BCFs) in the 1980 Human Health Methodology.³ Criteria developed using BAFs better represent exposures to pollutants that affect human health than do criteria developed using BCFs. The EPA's Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000); Technical Support Document Volume 2: Development of National Bioaccumulation Factors (2003) contains procedures for calculating BAFs. The EPA also recommends that states and authorized tribes calculate site-specific BAFs, where possible, for use in developing their state and authorized tribal human health water quality criteria. The EPA's Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000); Technical Support Document Volume 3: Development of Site Specific Bioaccumulation Factors (2009) contains procedures for calculating site-specific BAFs. The EPA applied the methodologies above in its 2015 human health criteria updates.

See Human Health Ambient Water Quality Criteria: 2015 Update (EPA 820-F-15-001 June 2015).

Use of BAFs in the calculation of water quality criteria for the protection of human health typically, if not always, results in more stringent criteria assuming all other factors in the calculation remain the same.